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TWENTYNINE PALMS, CALIFORNIA 92278-8285

FORECASTER'S HANDBOOK

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LOCAL AREA FORECASTER'S HANDBOOK

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FORWARD

1. This publication was prepared and revised in accordance with NAVOCEANCOMINST 3140.2E. This publication replaces the 20 October 1995 edition.

2. The primary purpose of the Forecaster's Handbook is to provide newly assigned weather Forecasters with the guidlines on local area weather conditions associated with typical synoptic scale developments. Services provided and forecasting techniques used are guidance to inexperienced and newly assigned Forecasters. This handbook also includes local climatology, special features, forecasting rules and aids used by MCAGCC, Twentynine Palms Forecasters.

3. All recommendations concerning changes, additions, or deletions to improve the effectiveness of this handbook are encouraged. Additional copies may be obtained by contacting this office.

J. D. LEWIS

RECORD OF CHANGES

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FORECASTER'S HANDBOOK

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SECTION I

BASIC DESCRIPTION

1. **STATION DESCRIPTION**

a. **Location**: The Expeditionary Airfield is located in Southern California at latitude 34 17'49"N and longitude 116 09'38'W. The field elevation is 2055 feet above mean sea level. The entire landing surface consists of AM-2 aluminum matting. The matting foundation is a highly compacted sand subbase. The one active runway 10/28 is 8000 feet by 150 feet and is oriented 104 degrees/284 degrees. (Please see Map 1-1) The Expeditionary Airfield Weather Service is co-located with Airfield Operations at the Expeditionary Airfield in building 2416.

b. **Topography**: The Mojave Desert and the Marine Corps Air Ground Combat Center are a mixture of earth colors and extremes in the desert. This area although austere in nature, features vast mountain ranges with varying terrain. The Mojave Desert is typically very dry with infrequent rain periods. South of the Combat Center is the city of Twentynine Palms. The local population is relatively sparse with about 8,200 residents. The airfield is surrounded by mountains ranging from 3500' to 11,500' MSL. The nearest are the Bullion Mountains oriented SE-NW and passing within 5 SM to the NE of the airfield (3800'-4700'MSL). To the S, the Joshua Tree National Park consists of several ranges, the closest being 15 SM (4800'-5800'MSL). The San Bernardino Mountains run from the SW to the NW at a ring of about 38 SM. These have the highest peaks in the area

c. **Facilities**: The Weather Office is located in building 2416, co-located with Airfield Operations. The building is a 6 wide trailer that houses the Weather Service, Airfield Operations, and Flight Clearance. It is located approximately ½ SM from Camp Wilson where Combined Arms Exercise Units (CAX) take place ten times per year.

d. **Local Area**: The Local Forecasting Area covers a radius of 25 nautical miles surrounding the Expeditionary Airfield. (See Map 1-3)

e. **Local Flying Area**: The Expeditionary Airfield local flying area is defined as that area covering a 50 mile radius surrounding the airfield. (See Map1-3)

f. **Mission**: The mission of the Expeditionary Airfield located on the Marine Corps Air/Ground Combat Center is to provide a support airfield for Third Marine Air Wing aircraft. The Airfield is part of the largest Air/Ground training facility in the Marine Corps. Ten Combined Arms Exercises (CAX) take place here each year along with providing readiness training for deployed squadrons during field carrier landing practice, night flying using IR goggles, and support of local tactical maneuvers. Desfirex, a combined helicopter exercise occurs here on a semiannual basis. Various additional keynote exercises such as Hunter Warrior occur here as part of the Marine Corps Strategic Training Plan.

2. **ENVIRONMENTAL SUPPORT SERVICES**

a. **General**: The Expeditionary Airfield supports both Aviation and Ground elements during Combined Arms Exercises (CAX) and local tactical operations. These exercises vary in size from Group to Regiment Level several times a year. The Expeditionary Airfield Weather Service also supports station units with current and forecast weather information.

b. **Support During Aviation Operations**:

(1) During CAX periods, weather observations are recorded 24 hours a day. Forecast services are also provided around the clock. During non-CAX periods, forecast Services are available Monday through Friday 0730-1630 unless field operational hours denote otherwise. Limited observational services are provided 24 hours a day. During CAX's, additional group briefs are provided upon request (i.e. strike briefs) to the Marines/Navy, Air Force, and Army units. Additionally, a 24 hour forecast is provided every morning to both aviation and ground elements by 0700L along with various additional weather products and information upon request.

(2) **TAFs (Terminal Aerodrome Forecast)** are issued at 0300Z, 0900Z, 1500Z, and 2100Z when the airfield is open and during exercises. Weather warnings, Weather advisories, and Conditions of Readiness are issued during operational hours in accordance with Squadron Order 3140.1B dated November 1995. During nonoperating hours, the weather service provides all weather warnings, advisories, and conditions of readiness as they apply.

c. **Environmental Requirements for Planning (Climatology)**: In addition to the above mentioned services, the weather office occasionally provides both G-2 and S-2 staff personnel with astronomical and climatological data. The requirements are normally restricted to the extent of Combat Center activities. Non-routine requests are accepted and handled on a case-by-case basis.

d. **Specialized Support Services**: Services tailored to special projects are available upon request. A wide spectrum of services for new construction aboard the Combat Center, resurfacing of the AM-2 Runway Matting, and the planning of a permanent Operations facility in the future, are typical of the type of requests submitted to the Weather Office for action. These forecasts are general in nature and are considered for the layman.

3. **METEOROLOGICAL INSTRUMENTS AND COMMUNICATIONS EQUIPMENT**

a. **General**: The Weather Office located at building 2416 houses the majority of the weather sensing devices and equipment.
Remote sights for the equipment are annotated on Diagram 1-1. Most meteorological equipment at the expeditionary airfield weather office comes under the cognizance of the Naval Meteorology and Oceanography Command (N51), Stennis Space Center, Mississippi. Meteorological equipment maintained by Aviation Meteorological Technicians, includes the following:

b. **Weather Office**:

(1) **Aerovane (ML 400/UMQ-5)**: The wind Bird is located 550 feet southeast of the operations building. It is located fifty meters away from active runway 28 on the North side. The recorder (RD-108B/UMQ-5) is mounted in the observers room. There are wind indicators in the forecasting area. Due to its close proximity of active runway 28, wind speeds are quite representative.

(2) **Weather Radar (AN/FPS-106)/Nexrad**: The Weather Office currently does not have Weather Radar capability.

(3) **Automated Surface Observing System (ASOS)**: This system is located approximatly ¼ mile Northeast of building 2416. The combined sensor group gathers and collects data automatically 24 hours a day.

(4) **Contel Meteorological Workstation (CMW)**: Is currently located in the Forecasting/Observering room.

(5) **Rain Gauge (ML217)**: A four inch plastic rain gauge is the primary precipitation measuring instrument. This gauge is mounted on a four foot pole located approximately 50 feet south of the Operations building.

(6) **Aneroid Barometer (ML 448)**: Is mounted on the East wall of the Forecasters/observers room.

(7) **Marine Barograph ML-2**: Is located in the Forecater/observers room.

(8) **Theodolite ML-474**: A permanent site is located approximately 60 feet due south of the Operations building.

(9) **WBGT Equipment**: The primary WBGT setup is located 55 feet southeast of the operations building and includes the following.

a. **ML-421 Thermoscreen:**

b. **Min/Max Temperature Thermometers.**

c. **Globe Thermometer**

d. **Wet Bulb Thermometer**

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(10) **Pilot to Forecaster Service GRC 171**: The remote box (GRC-171) is located in forecasters/observers room. The radio is a TT-8/800 FRC with a transmitter/receiver located on the south side rooftop of the operations building. The metro frequency 308.3 MHZ.

(11) **Optimum Path Aircraft Routing Systems (OPARS)**: The NODDS System is the primary system used in obtaining a computer flight plan from FNOC Monterey, Ca.

(12) **Metoc Integrated Data Display System (MIDDS)**: The MIDDS provides both Forecaster and Observer with a variety of data at their fingertips. The System is capable of retrieving facsimile information, satellite pictures, or OPARS, just to name a few. This system integrates various products into one system which increases the capability and speed of weather personnel to perform their duties.

4. EARTHQUAKES AND FAULT LINES IN SOUTHERN CALIFORNIA

a. **Scientific Theory**: The concept of moving plates is now fundamental to the theory of Continental Drift, which has been long disputed but is now generally accepted based on geological, geophysical, and geo-chemical science.

The San Andreas Fault system forms the boundary between the North American Plate and the North Pacific Plate and separates southwestern California from the remaining North America. In general, the North American Plate is moving Northwestward. The rate varies from 1 ½" to 2 ½ " per year. Since the plate began it's northwesterly movement, it has moved about 720 Miles over thirty-two million years. Some horizontal displacements up to 21 Feet were recorded during the San Francisco Earthquake of 1906 (8.3 on the Richter Scale). The San Andreas Fault is not the simple line one may picture it to be. From the Gulf of Baja to the Salton Sea through the San Joaquin Valley to the north of the fault line, it is oriented with the coastline and mountain ranges (generally northwest-southeast). But the deep roots of the Sierra Nevada and San Bernardino Mountain ranges combined with the transverse around Santa Barbara, along with San Gabriel Mountains and the Garlock Fault in the Mojave Desert reorient the plate movement to a more east-west trend. This region of over-thrusting is considered locked by most seismologists. Much of the strain, however, parallels along faults to the San Andreas and by over thrusting on both sides of the fault.

The San Andreas Fault passes within forty miles of the Combat Center's Expeditionary Airfield. The fault line continues from the San Joaquin Valley through Banning Pass and Cajon Pass into the Antelope Valley near Palmdale.

The University of California Berkeley and the Cal Tech Seismological Laboratory have monitored southern California earthquake activity for over 40 years. From 1956 to 1992, a 36 year period, over 7300 earthquakes have occurred with a magnitude of 4.0 or greater. The strongest earthquake during this period was the 1952 Kern County quake (7.7 magnitude on the Richter Scale). Since then, massive quakes occurring in both Los Angeles and Landers very recently, further proves the diversion of the sliding lithosphere is active and consistent with scientific conclusions. The weather facility submits all earthquake reports to the Branch of Global Seismology located in Denver, Colorado.

SECTION II

CLIMATOLOGY (GENERAL)

1. **CLIMATE**

a. **Introduction**: The Marine Corps Air Ground Combat Center lies in the southern portion of the Mojave Desert. The Pacific Ocean is only 100 nautical miles to the west but the San Bernardino Mountains act as a barrier. The Maritime Polar Air masses undergo significant modification across the region due to the barrier created by this mountain range. "Monsoonal Flow" at its peak normally in July-August create further complications due to the Northwest-southeast orientation of the San Bernardino Mountains and the local wind circulatory pattern. This unique combination makes for an interesting climatic pattern.

b. **Classification:** The high desert region of California closely resembles a high elevation Mediterranean climate. During the summer, the North Pacific High dominates the local area weather pattern. The large scale semi-permanent pressure system provides a fairly stable region throughout the warm months. During the July-August time frame, convective and orographic weather may occur due to southwesterly flow from the seas. Very hot, windy, and dusty outbreaks frequent this area, due to the surrounding thermal low pressure areas.

c. **Major Controlling Features:** Two seasons occur at Twentynine Palms, California. Summer and a cool season, November through March. Modified Maritime Polar air masses provide dry weather. During the winter, sporadic intrusions of Continental Polar air advected over the San Bernardino Mountains brings cloudiness and precipitation. Transitional Periods are marked by rapid temperature change and wind circulation patterns.

2. **SUMMER WEATHER AND ASSOCIATED AIR MASSES**

a. **Scientific Theory. General:** During the Summer months, the synoptic pattern is dominated by a warm core thermal low from southern Nevada to southern Arizona. The low is created primarily in part by the subtropical ridge aloft, producing clear skies and occasional cirrus clouds. Circulation at the Expeditionary Airfield begins from the east during the morning hours and becomes more southerly during the day. On extreme heating days the optimum direction is 210 degrees (at Banning Pass) as the low begins to rapidly fill after peak heating hours (generally between 1400-1600).

A relatively strong high pressure system develops each summer centered around 40 degrees north to 150 degrees west. Generally, the trough aloft stays just off the California coastline (at 125 degrees W) but on occasion will deepen and move far enough southeast to produce a southwesterly flow aloft and some cirrus will move into the area. The flow pattern rarely changes aloft and the Polar Jet Stream's orientation stays well north until after October.

Occasionally, a slow moving high will position itself over the Texas-New Mexico region. East-Southeasterly winds become routine during the day. The four corners over Arizona-Colorado provides some support for the same easterly flow pattern. Summer thunderstorm activity is usually a product of the monsoonal flow typically occurring after the July-August time frame.

When thunderstorms do develop, they are normally of a very short duration. Precipitation is normally minimal associated with cells that may be classified as the "garden variety" type. Air mass thunderstorms typically form in and around the mountain ranges and are predominantly stationary. Thunderstorm development is common along the coastal upslope and the major peaks to the southwest. (Mt. San Jacinto and Mt. San Gorgonio).

3. **TRANSITION PERIODS**: During April and May, the summer transition begins while October and November mark transitional periods for the winter months. This is normally occurs within a 45 day period. Winds will typically increase at these times affecting the transition. On occasion, weak frontal systems move through our local area during the winter months. However, most winter frontal systems only effect coastal regions due to the mountain barriers. The effects that do occur are gusty surface winds and increased upper level cloud cover.

4. **SPECIAL FEATURES**

a. **Introduction**: The disturbances and weather systems associated with the jet and frontal systems, the thermal low pressures systems that effect the high desert region and various other special features, outline the proceeding chapters. Although not intended to supplement forecasting parameters, they are intended to provide a sound focus and to incur understanding of the uniqueness and peculiarities experienced in the desert region.

b. **Thermal Low/Trough**: This semi-permanent pressure system is referred to as an inverted trough or heat low. The trough is formed by the intense daily heating of the desert areas of southern California, western Arizona, and northwestern New Mexico. The position of the inverted trough or heat low typically varies seasonally. During the summer months, the position of the heat low with an associated inverted trough poses a forecasting problem concerning the winds for the Twentynine Palms region.

First, surface winds are extremely difficult to forecast since the trough axis fluctuates back and forth over the Twentynine Palms area during the day. Second, there are little to no indications of pressure gradient present within our forecasting area. Depending on the degree of heating during the day and when the low fills, winds present a special problem. Wind speed associated with the thermal low may average 10-16 knots with a well developed low to light and variable with a weak low present. During the winter months, the lowest pressure is generally over northwestern New Mexico. The trough associated with the low may extend as far north as Northern California in the winter.

c. **Seasonal Monsoon**: During the summer season, especially July and August, high levels of heat and humidity form what is known as the "Monsoonal Season". This condition normally commences in early July and persists, with occasional outbreaks until mid-September. Increased solar insulation, combined with maritime flow, produce the heat and humidity. Drycontinental air is replaced by moist, tropical air, making for extremely uncomfortable temperatures in this region. Also, the monsoonal flow increases the development of desert thunderstorms that often produce dangerous microbursts and heavy rains.

d. **Frontal Activity in the Desert**: Cold fronts advancing rapidly toward the Pacific West Coast often undergo a weakening process that leads to reduced convection and dissipation of the associated cloud band. Satellite imagery may not reveal the presence of these systems by the time they reach southern California. They are normally termed as "dry fronts" and are followed by strong northwesterly winds. The "dry fronts" are of major concern to aviation operations throughout the Combat Center.

e. **Frontal Shearing**: The land masses that surround the Mojave Desert region are of significant importance in forecasting the intensity of frontal systems as they approach the Combat Center. The San Bernardino Mountain Range west of the station, is quite capable of causing "Frontal Shearing". A situation may occur where the seaward portion of an advancing cold front may advance more rapidly than the inland portion, thus resulting in horizontal shearing across the frontal zone at the coastline. At the same time, the inland portion may remain intact retaining some degree of cloudiness and convection in a large part due to orographic effects. Miscalculation may occur in frontal positioning resulting in erroneous forecasts.

Typical satellite imagery may very well show the well-developed cloud formations associated with the inland portion. However, the seaward portion may only reveal an area of enhanced cloud cover just off the Southern California coastline. Forecasters need to pay particular close attention to the winds upstream. A solid indicator would be gusty surface winds in the vicinity of the enhanced cloud cover that has an area of clearing, while the inland portion produces little in the way of wind.

Also the southern periphery may move through our area producing little in the way of weather but much in the way of winds. Frontal systems approaching the west coast are also known to undergo "vertical shearing". Here, the mid and high level clouds become separated from the lower cloud band and move eastward at a rapid rate. This occurs when associated upper level troughs tilt eastward with height. This is a good indication that the system is weakening and further cloud cover and/or precipitation will decrease.

5. POST FRONTAL SQUALL LINES

a. **Scientific Theory:** Fronts rapidly approaching the west coast from the northeast Pacific Ocean rarely exhibit the sharp horizontal temperature gradient across their surface boundaries that the East Coast fronts do with regularity. Post frontal squall lines rarely occur over our region due to horizontal and vertical shearing of fronts as previously mentioned. The significant rains, winds, etc. may be attributed to a post frontal situation. Although most cold fronts passing through this area are weak, close attention should be paid to the potential for enhanced cumuliform development after frontal passage.

There may be little to no indication that a post frontal squall line exists. Particular close attention needs to be paid to intense low pressure systems as they move into our vicinity. Although horizontal shearing is likely to occur, the development and possibility of troughing does in fact exist. Being mindful of slow moving areas of cloud cover and precipitation shields after frontal passage. These are typical indicators of post frontal activity during the winter months. Satellite imagery may produce a clear indication as clouds resembling minor to major shortwaves with no associated fronts in the area move into our region. Weather produced from these systems is typically light to moderate precipitation, extensive cloud shields, and gusty surface winds. There are no known occurrences of severe weather recorded at this station associated with post frontal squall lines. Forecasting tools that have provided sound guidance are the 850 millibar analysis, thickness charts, and the NGM's.

6. **OROGRAPHIC CLOUD DEVELOPMENT AND PRECIPITATION PATTERNS**

a. **ScientificTheory:** The San Bernardino Mountains act as an effective high level heat source or as a cloud generator during the day. At night, they suppress cloud formation and can even dissipate clouds. The primary determinant of clouds and associated precipitation is the height of the mountain tops and the variance of convective condensation levels. When the condensation level or cloud base is considerable lower that the mountain tops, cloud growth and precipitation take place on the windward side of the mountain range. The mechanical lifting of moist air is the most important mechanism for the release of latent heat of condensation. It has been shown that stable air moving over an orographic barrier produces little to no cloud cover or precipitation. Even smaller mountain ranges in our general vicinity that block rapid monsoonal flow produce significant precipitation on the windward side. A key indicator in determining whether or not precipitation will occur on the leeward is the height of the condensation level and if its on the leeward side. Convective clouds that form on or near the peak of the leeward side, produce precipitation as they drift away from the ridge line. Such cloud formations are quite common over the Mojave Desert, Nevada, Utah, and Arizona with respect to orography. Heat of the mountain slopes plays an important part in the acquisition of buoyancy by orographic cumulus. This is especially true when the wind flow is southerly producing moderate cumuliform cloud formations and precipitation. The combination high cloud bases with high wind speeds generally produces widespread precipitation shields. In respect as to the effect mountain barriers have on thunderstorm development in this region offer some peculiarities. First, a southwesterly flow over the San Bernardino Mountains is very capable of producing isolated cells within the vicinity of the Combat Center. Second, unstable air-masses that typically give the appearance of producing thunderstorms, tend not to do so if due to rapid cooling at the condensation level. Finally, monsoonal flow often produce the majority of our thunderstorm development with respect to orographic lift.

7. **CUTOFF LOWS**

a. **Cutoff Lows**: During the winter months, a long wave trough, will sometimes become nearly stationary just off the west coast of California. Short waves in secession typically transverse the area as new surges of cold air enter upstream of the long wave. In the rear of the trough, an insulated pool of cold air and a closed low aloft may form. Once the closed low becomes displaced equatorward out of the polar front jet, it becomes "cutoff". Once upper level dynamics indicate the low resembling a barotropic system, the low tends to slow its forward movement and eventually becomes stationary. A cold pocket aloft is also a strong indicator of its barotropic nature.

Normally forming in 24 to 48 hours, these lows will persist for a 24 hour to two week period before dissipating. A low that is well developed will have an effect on the Twentynine Palms area weather if we fall under a cyclonic rotational quadrant. Generally, multiple layers of clouds with ceilings as low as 2,000 ft and periods of light to moderate precipitation can be expected. These lows are most pronounced during the December-February time frame.

b. **Nevada Lows**: A "Nevada Low" is a local core low name to the reflection at the surface of an upper level closed or deep trough over Nevada. The Nevada Low is typically a cold core system which develops during the February-April time period. This low generally produces strong pressure gradients over Southern California, Nevada, Utah, and western Arizona. The conditions for development of the Nevada Low are very similar to those of the Cutoff Low. The low normally develops:

(1) As a wave on an East-West oriented front.

(2) As a secondary low in an unstable air-mass following the passage of a frontal system.

(3) Beneath a Cutoff Low.

(4) At the southern tip of a long-wave trough as a jet maximum moves over the region.

A well defined frontal zone is usually observed over southern California, Nevada, and the Utah Desert areas once the low is well established. Although significant cloudiness and precipitation are not experienced at Twentynine Palms with the Nevada Low, at times, minor short wave troughs or vorticity lobes moving around the low will pass over the local area producing mid to high level clouds and strong gusty surface wind. Some cumuliform cloud development can also be expected.

The greatest challenge to any forecaster with a storm of this nature undoubtedly is time. Nevada Lows are intense storms that move very rapidly with time. The wind fields associated with these storms can produce winds in excess of fifty knots with little or no warning. For example, on March 26, 1984 a Nevada Low developed shortly after sunrise over Lake Mead located 150 miles east-northeast of the Combat Center. By 1100 PST, surface winds were 270 degrees at 18 knots with gusts to 27 knots. By 1340 PST, the winds increased to 290 degrees at 26 knots with gusts to 35 knots. The surface wind remained strong throughout the day with gusts in excess of forty knots. The absolute peak wind occurred at 2200 PST with a gust to 54 knots. The best forecasting tool to utilize in most cases is to constantly check the gradient. Occasional IFR conditions with blowing sand and dust can be expected. Although most cases are not this severe, strong winds can be anticipated with these storms.

8. COASTAL ZONE PHENOMENA

a. **Introduction**: The presence of widespread stratus along the California coast is most pronounced during the warm months, May through September. Coastal stratus advances inland during the night and early morning hours, and burns off by afternoon. This primarily is the result of diurnal effects and the presence of the California current along the coast. The presence of coastal stratus rarely presents a problem for this station as the San Bernardino Mountains act as a solid barrier. The presence of intense subsidence over the desert region also prevents the formation of stratus over our area.

Another phenomenon which disrupts the normal diurnal oscillation of the stratus along the southern California coast is a small scale vortex called the "Catalina Eddy". The eddy plays a significant role in deepening the "Marine Layer" and prevents the diurnal change from occurring as one would normally anticipate. If the eddy is strong, the marine layer will deepen rapidly, obscuring the coastal region and blanketing Los Angeles and nearby valleys. This is in contrast to the lowering of the marine layer under fair weather conditions, which favors a strong sea breeze development, divergent flow across the coastline, and dissipation of the stratus far out to sea.

b. **Coastal Stratus "The Marine Layer"**: From May to September, extensive low-level cloudiness (stratus and stratocumulus) is observed along the U.S. West Coast. The low level cloud is due to a number of oceanographic and atmospheric factors. The primary oceanographic factor is the California current-a wide, cold current present in the Eastern Pacific that moves southward along the west coast. The atmospheric factor is the persistent northerly winds blowing around the semi-permanent anti-cyclonic circulation over the Eastern Pacific during the Summer. The winds produce a significant "upwelling" that extends out into the California current.

The extensive areas of coastal stratus is formed when warm, moist, maritime Pacific air moves southward, around the eastern periphery of an offshore anticyclone, and is cooled from below by cold water associated with the California current and the upwelling coastal waters. As the air moves south over progressively warmer waters, the marine layer tends to deepen, becomes higher in elevation, and increasingly unstable.

The marine layer is capped by a dry stable layer aloft (temperature inversion) due to subsidence associated with the the eastern periphery of the anticyclone. The stratus forms below the base of the inversion which is typically between 1,000 and 2,000 feet thick. Typically, early morning coastal stratus dissipates rapidly out to sea, leaving a cloud free channel just offshore by afternoon. When there are no synoptic scale disturbances over the ocean moving toward the California coast, a marked diurnal cycle in the stratus cloud cover occurs along the coastal zone.

c. **Important Conclusions**

(1) Persistent coastal stratus penetrate inland in coastal valleys and is restricted to the coastal strip by hilly terrain.

(2) Under fair weather conditions, onshore coastal stratus dissipates rapidly during daytime surface heating, and the onshore edge retreats to the shore and then offshore, leaving a clear area along the coast.

(3) Daytime offshore coastal stratus dissipation distances are greatest in regions where sea breeze circulation's develop along curved coastlines with inland coastal plains. The

"Marine Layer" is a coastal phenomenon and rarely effects this station. But, due to operational tempo, it's a significant feature for aircraft operating out of the local flying area.

(4) Note: for more specific forecasting rules on forecasting Marine layer formation and dissipation see Camp Pendelton's Forecaster Handbook.

d. **Mesoscale Cloud Eddies in the "Marine Layer"**: Mesoscale cyclonic eddies are observed off the southern coast of California during the year. The most vigorous eddies are a warm phenomenon occurring from May to September. Since the circulation center of these eddies is frequently located near the Catalina Island, they are called "Catalina Eddies". The eddies are identified as a spiral-shaped stratus cloud pattern by satellite imagery that forms in the offshore marine layer.

e. **Catalina Eddies**: The typical Catalina Eddy is observed to develop simultaneously with movement of maritime cold front from the North Pacific through the Pacific Northwest. To the rear of the front, a wedge of the high pressure builds inland so that strong, dry, northerly flow develops offshore along the California coast.

A useful tool in forecasting the onset of the "Catalina Eddy" are vorticity values and the 500MB heights and vorticity progs. Although developed for the Los Angeles area, the basic concept is applicable to other coastline areas with similar topographical features.

Once formed, the Catalina Eddy will persist until either a frontal passage occurs or the vorticity maximum aloft passes. The marine layer then deepens to 5,000 feet, spilling over the coastal mountain range into the high desert or general onshore flow develops east of the California coast.

Note: Significant gradient level winds need to be present in this vicinity for the cloud formations to occur at this station. Forecasters need to be aware that this is strictly a coastal phenomenon that can produce stratocumulus formations if significant gradient level winds persist.

f. **Santa Ana Winds**: During periods of high pressure in the upper plateaus of the Nevada and California Deserts, a Foehn wind develop within the regions of passes and valleys in the west of the coastal mountain ranges. Normally, this occurs during the months of December, January, and February. Locally these winds are referred to as "Santa Ana" winds because of the path they follow into Orange County, the "Santa Ana" river bed. There are three major passes that funnel the high pressure from the deserts down into the Los Angeles and Orange County Basins 2,000 feet below. They are the Banning, Cajon, and Tejon Passes. The air traveling down through these passes is compressed and accelerated during decent to the coast. Velocities through these passes depends largely on the pressure differential between the coastal stations and the deserts.

Typically the wind on the coast range from 15 to 45 knots but isolated velocities of 80 to 90 knots have been recorded. The Combat Center doesn't experience the high winds of a Santa Ana condition. The pressure buildup here can be extreme during a Santa Ana condition. Temperatures at the airfield are usually mild with the influx of a new high pressure system.

9. **HAZARDOUS WEATHER PHENOMENON**

a. **Thunderstorms**: Summer is the prime season for thunderstorms but can occur any month of the year. The majority of activity is in the surrounding mountain areas and on occasion, a storm will actually pass over the station. Thunderstorm bases are usually high, between 5,000 - 6,500 feet, however; bases have been recorded as low as 3,000 feet.

Precipitation that normally accompanies these storms are of the light to moderate variety. Some heavy showers occur each year causing local flash flooding that affects the Morongo Basin due to very poor drainage systems and extremely dry sand. Normal periods of thunderstorms are short, occurring usually in late afternoon or evening hours. When large amounts of moisture are available (monsoonal flow), thunderstorm activity can linger for days and may occur at any hour. Thunderstorms associated with fronts are rare in the western Mojave Desert.

b. **Visibility Restrictions** The primary restrictors to visibility at this station are blowing sand and/or precipitation. The thunderstorms are very capable of producing significant downburst that can reduce visibility with blowing sand and dust. Typically, a thunderstorm with gusty surface winds of 35 knots can reduce visibility to less than a mile.

Although precipitation does not reduce the visibility as much or as rapidly as blowing sand, it does occur. At times, heavy to moderate shower activity will reduce the visibility 2-4 miles. During the summer months, precipitation induced fog can occur but on very rare occasions. The dry lake beds, at times, have water in them and may produce light fog on cool mornings, but dissipates quickly after sunrise.

c. **Gusty Winds (Summer)** During the summer months, winds are typically caused by thunderstorms and local effects associated with the Thermal Low. Thunderstorms are the primary cause of high winds during the summer months. Downburst speeds at the EAF have been recorded as high as 58 knots during the spring of 1984 which destroyed the Tacan completely.

A secondary reason for the high winds during the summer months is extreme heating. Temperatures for the EAF average between 110-114 degrees on an average summer day. Pressure falls are rapid throughout the day as the thermal low deepens. When maximum heating is reached, the low begins to fill. A major source of this filling air is through Banning Pass where afternoon and evening winds average 40-45 mph as the coastal pressure high pressure feeds into the deserts. Surface winds recorded at this station associated with afternoon heating have been recorded in excess of 45 knots but usually don't exceed 37 knots. Haze may also accompany these winds because the lithometers are transported from Los Angeles and may reduce the visibility to as low as 3 miles. Fixed wing flying is hazardous due to crosswinds. The runway is on a 280 degree heading and "Banning Pass" winds approach on a 210 degree heading. Light aircraft and helicopters on many occasions experience light to moderate turbulence due to extreme surface heating.

d. **Gusty Surface Winds (Winter)**: Winds during the winter months are typically associated with upper level troughs and/or surface cold fronts. The winds associated with these systems generally flow through the local mountain passes or flow down natural corridors within the mountains from Nevada and Utah (the Great Basin).

e. **Hail**: Thunderstorm zero degree isothermal levels are usually too high to allow hail to reach the desert floor. The fall and spring periods is the most likely time for hail to occur, especially if the jet stream is supporting storm development.

f. **Tornadoes**: Tornado reports are extremely rare in the high desert but do occur. The airfield took a direct hit in September 1982 with a tornado passing from southeast through northwest. The airfield sustained major damage; winds associated with the storm were recorded as high as 62 knots.

g. **Dust Devils**: Dust Devils are often confused with tornadoes by laymen. On hot days with light winds, the thermal lifting causes strong updrafts and swirls of dust may be seen moving across the desert. They, don't cause the damage tornadoes are capable of.

h. **Turbulence**: Upper level turbulence is primarily speed and directional shear associated with jet stream activity. Low level turbulence is caused by circulation over and around mountainous terrain. Low level wind shear is usually present in the passes. Orographic and mechanical turbulence is present over most major peaks and ridges.

A rule of thumb to follow in forecasting mechanical turbulence is to double the height of terrain for speeds up to 24 knots and triple terrain heights for speeds greater than 24 knots. Thermal lows are plagued with moderate to strng updrafts during May heating hours. In July, updrafts may occur as high as 13,000 feet. Helicopters and light aircraft normally experience moderate turbulence, especially over dry lake beds and valleys during the day.

i. **Flooding**: Flooding is a hazard not only to low lying areas but to the runway as well. The Expeditionary Airfield consists of over 3,000,000 square feet of AM-2 aluminum matting on a sand base. Heavy rains may cause severe damage to the subsurface and may even wash portions away. Flash floods may occur with as little as 1/2" of rain. Phone lines, power lines, and access roads are often washed out for short periods of time during flash flooding.

JANUARY CLIMATOLOGICAL SUMMARY

TEMPERATURES:
Average Daily Maximum.............................63
Average Daily Minimum.............................38
Extreme Maximum (1994)............................82
Extreme Minimum (1982)............................17

VISIBILITY: *Equal or Greater than*
21/2 Mile...99.8%
3 Miles..99.4%
6 Miles..99.2%

CEILINGS: *Equal or Greater than*
200 Ft...99.9%
500 Ft...99.8%
1000 Ft...98.8%
3000 Ft...96.6%
5000 Ft...73.0%
No Ceiling..68.4%

PRECIPITATION:
Monthly Mean.......................................0.49”
Extreme Maximum (1993).....................2.69”
Extreme Minimum (1984)......................0.00”
24 Hour Maximum (1995)......................1.02”

RELATIVE HUMIDITY:
Mean Relative Humidty.........................46.0%
Mean at 0100L.....................................58.0%
0700L.....................................52.6%
1300L.....................................35.9%
1900L.....................................42.5%

FIELD COND. AND SKY COVER:
VFR..100%
IFR..0.0%
Below Minimums...................................0.0%
Mean Sky Cover (eigths)...........................4.3
Clear...20.3%
Few (0.1-0.2).......................................22.0%
Scattered (0.3-0.4).................................19.7%
Broken (0.5-0.7)....................................28.2%
Overcast (0.8)..9.8%

WEATHER CONDITIONS: (# of days)
Thunderstorms..0
Rain and/or Drizzle.......................................3
Snow..0
Fog...0
Obstructions to Vision...................................0

PREVAILING WIND DIRECTION AND SPEED

Percent of Time of Most Frequent Direction and Mean Speed
22.3% WNW 11.3 Knots
Percent of Time of Second Most Frequent Direction and Mean Speed
22.1% W 6.8 Knots
Percent of Time of Third Most Frequent Direction and Mean Speed
16.7% NNW 14 Knots
Extreme Peak Gust: 1996 WNW 53 Knots

Percent of Time Wind Was:
17 Knots or Greater.................................6.7%
11-16 Knots..20.0%
7-10 Knots...36.8%
4-6 Knots..27.0%
1-3 Knots..3.8%
Calm...5.5%

FEBRUARY CLIMATOLOGICAL SUMMARY

TEMPERATURES:
Average Daily Maximum..............................67
Average Daily Minimum..............................41
Extreme Maximum (1996)............................87
Extreme Minimum (1989)............................20

VISIBILITY: *Equal or Greater than*
21/2 Mile..99.9%
3 Miles...99.4%
6 Miles...99.3%

CEILINGS: *Equal or Greater than*
200 Ft...100%
500 Ft...100%
1000 Ft...98.0%
3000 Ft...93.9%
5000 Ft...68.2%
No Ceiling..60.0%

PRECIPITATION:
Monthly Mean..0.50”
Extreme Maximum (1992).....................2.20”
Extreme Minimum (1984,89)..................0.00”
24 Hour Maximum (1992).....................1.17”

RELATIVE HUMIDITY:
Mean Relative Humidty.........................44.8%
Mean at 0100L......................................54.1%
0700L......................................53.7%
1300L......................................31.1%
1900L......................................40.1%

FIELD COND. AND SKY COVER:
VFR...100%
IFR...0.0%
Below Minimums...................................0.0%
Mean Sky Cover (eigths)............................4.9
Clear...16.5%
Few (0.1-0.2)...7.9%
Scattered (0.3-0.4)..................................27.0%
Broken (0.5-0.7)......................................33.6%
Overcast (0.8)..12.1%

WEATHER CONDITIONS: *(# of days)*
Thunderstorms..0
Rain and/or Drizzle..4
Snow...0
Fog..1
Obstructions to Vision....................................1

PREVAILING WIND DIRECTION AND SPEED

Percent of Time of Most Frequent Direction and Mean Speed

31.3% W 6.8 Knots

Percent of Time of Second Most Frequent Direction and Mean Speed

18.9% NW 12.0 Knots

Percent of Time of Third Most Frequent Direction and Mean Speed

18.7% WNW 11.3 Knots

Extreme Peak Gust: 1987 SW 64 Knots

Percent of Time Wind Was:
17 Knots or Greater...............................11.1%
11-16 Knots..24.2%
7-10 Knots..33.9%
4-6 Knots..25.6%
1-3 Knots..3.7%
Calm...1.4%

MARCH CLIMATOLOGICAL SUMMARY

TEMPERATURES:
Average Daily Maximum..............................73
Average Daily Minimum..............................46
Extreme Maximum (1994)............................97
Extreme Minimum (1985)............................26

VISIBILITY: *Equal or Greater than*
21/2 Mile...100%
3 Miles...99.7%
6 Miles...99.7%

CEILINGS: *Equal or Greater than*
200 Ft...100%
500 Ft...100%
1000 Ft..99.4%
3000 Ft..95.7%
5000 Ft..74.1%
No Ceiling...69.2%

PRECIPITATION:
Monthly Mean...0.50"
Extreme Maximum (1991)......................1.61"
Extreme Minimum (1984,97)..................0.00"
24 Hour Maximum (1992).......................0.89"

RELATIVE HUMIDITY:
Mean Relative Humidty.........................40.7%
Mean at 0100L......................................46.2%
0700L......................................52.4%
1300L......................................28.8%
1900L......................................35.3%

FIELD COND. AND SKY COVER:
VFR..100%
IFR...0.0%
Below Minimums...................................0.0%
Mean Sky Cover (eigths)............................4.0
Clear..18.8%
Few (0.1-0.2)..37.2%
Scattered (0.3-0.4)...................................7.7%
Broken (0.5-0.7)....................................27.9%
Overcast (0.8)..8.3%

WEATHER CONDITIONS: *(# of days)*
Thunderstorms..1
Rain and/or Drizzle..4
Snow..0
Fog..1
Obstructions to Vision....................................1

PREVAILING WIND DIRECTION AND SPEED

Percent of Time of Most Frequent Direction and Mean Speed
35.3% WNW 10.3 Knots
Percent of Time of Second Most Frequent Direction and Mean Speed
23.5% W 8.0 Knots
Percent of Time of Third Most Frequent Direction and Mean Speed
11.8% NW 7.0 Knots
Extreme Peak Gust: 1991 SSW 54 Knots

Percent of Time Wind Was:
17 Knots or Greater...............................11.3%
11-16 Knots...28.1%
7-10 Knots...31.9%
4-6 Knots...23.7%
1-3 Knots...4.6%
Calm...0.4%

APRIL CLIMATOLOGICAL SUMMARY

TEMPERATURES:
Average Daily Maximum..............................80
Average Daily Minimum.............................54
Extreme Maximum (1996).........................101
Extreme Minimum (1983)............................37

VISIBILITY: *Equal or Greater than*
21/2 Mile..100%
3 Miles..99.9%
6 Miles..99.8%

CEILINGS: *Equal or Greater than*
200 Ft..100%
500 Ft..100%
1000 Ft..100%
3000 Ft..99.9%
5000 Ft..83.0%
No Ceiling...81.4%

PRECIPITATION:
Monthly Mean.......................................0.07”
Extreme Maximum (1988)......................0.62”
ExtremeMin(79,81,84,89,91,93,94,96,97)0.00”
24 Hour Maximum (1992).....................0.21”

RELATIVE HUMIDITY:
Mean Relative Humidty.........................31.6%
Mean at 0100L......................................37.5%
0700L......................................41.8%
1300L......................................21.2%
1900L......................................26.0%

FIELD COND. AND SKY COVER:
VFR..100%
IFR..0.0%
Below Minimums...................................0.0%
Mean Sky Cover (eigths)...........................3.2
Clear..24.5%
Few (0.1-0.2).......................................29.3%
Scattered (0.3-0.4)................................16.3%
Broken (0.5-0.7)....................................25.1%
Overcast (0.8)..4.7%

WEATHER CONDITIONS: *(# of days)*
Thunderstorms..1
Rain and/or Drizzle..1
Snow...0
Fog...0
Obstructions to Vision...................................1

PREVAILING WIND DIRECTION AND SPEED

Percent of Time of Most Frequent Direction and Mean Speed			
	42.1%	W	4.1 Knots
Percent of Time of Second Most Frequent Direction and Mean Speed			
	21.0%	WNW	12.8 Knots
Percent of Time of Third Most Frequent Direction and Mean Speed			
	15.8%	NW	15.3 Knots
Extreme Peak Gust:	1996,1997	WNW, NW	50 Knots

Percent of Time Wind Was:
17 Knots or Greater...............................21.5%
11-16 Knots..28.2%
7-10 Knots..33.7%
4-6 Knots..14.9%
1-3 Knots..1.7%
Calm...0.0%

MAY CLIMATOLOGICAL SUMMARY

TEMPERATURES:
Average Daily Maximum..............................74
Average Daily Minimum...............................89
Extreme Maximum (1996)..........................108
Extreme Minimum (1980)............................40

VISIBILITY: *Equal or Greater than*
21/2 Mile...100%
3 Miles...100%
6 Miles..99.9%

CEILINGS: *Equal or Greater than*
200 Ft...100%
500 Ft...100%
1000 Ft..99.4%
3000 Ft..97.4%
5000 Ft..81.7%
No Ceiling...78.5%

PRECIPITATION:
Monthly Mean.......................................0.08”
Extreme Maximum (1982).....................0.69”
ExtremeMin (83,84)...............................0.00”
24 Hour Maximum (1982).....................0.66”

RELATIVE HUMIDITY:
Mean Relative Humidty.........................30.0%
Mean at 0100L......................................37.5%
0700L......................................37.5%
1300L......................................19.5%
1900L......................................24.3%

FIELD COND. AND SKY COVER:
VFR...100%
IFR..0.0%
Below Minimums...................................0.0%
Mean Sky Cover (eigths)............................3.3
Clear..25.9%
Few (0.1-0.2)..32.9%
Scattered (0.3-0.4).................................14.1%
Broken (0.5-0.7)....................................23.7%
Overcast (0.8)..3.2%

WEATHER CONDITIONS: *(# of days)*
Thunderstorms..0
Rain and/or Drizzle.......................................2
Snow...0
Fog...0
Obstructions to Vision...................................0

PREVAILING WIND DIRECTION AND SPEED

Percent of Time of Most Frequent Direction and Mean Speed			
	31.6%	WNW	10.8 Knots
Percent of Time of Second Most Frequent Direction and Mean Speed			
	26.4%	NW	11.0 Knots
Percent of Time of Third Most Frequent Direction and Mean Speed			
	26.2%	W	9.4 Knots
Extreme Peak Gust:	1988	N	54 Knots

Percent of Time Wind Was:
17 Knots or Greater.................................9.6%
11-16 Knots..29.3%
7-10 Knots..34.5%
4-6 Knots..22.1%
1-3 Knots..4.5%
Calm...0.0%

JUNE CLIMATOLOGICAL SUMMARY

TEMPERATURES:
Average Daily Maximum...........................100
Average Daily Minimum.............................68
Extreme Maximum (1994).........................121
Extreme Minimum (1993)............................43

VISIBILITY: *Equal or Greater than*
21/2 Mile..100%
3 Miles...100%
6 Miles..99.9%

CEILINGS: *Equal or Greater than*
200 Ft..100%
500 Ft..100%
1000 Ft..100%
3000 Ft..100%
5000 Ft..92.6%
No Ceiling..92.4%

PRECIPITATION:
Monthly Mean.......................................0.06”
Extreme Maximum (1984).....................0.69”
ExtremeMin (81,83,86-9,92,93,96,98)...0.00”
24 Hour Maximum (1984)....................0.66”

RELATIVE HUMIDITY:
Mean Relative Humidty.........................25.2%
Mean at 0100L......................................28.8%
0700L......................................33.0%
1300L......................................19.0%
1900L......................................19.8%

FIELD COND. AND SKY COVER:
VFR..100%
IFR..0.0%
Below Minimums...................................0.0%
Mean Sky Cover (eigths)...........................1.7
Clear...49.7%
Few (0.1-0.2)..28.8%
Scattered (0.3-0.4)...................................8.9%
Broken (0.5-0.7)...................................12.0%
Overcast (0.8)...0.6%

WEATHER CONDITIONS: *(# of days)*
Thunderstorms..1
Rain and/or Drizzle..1
Snow..0
Fog...0
Obstructions to Vision....................................0

PREVAILING WIND DIRECTION AND SPEED

Percent of Time of Most Frequent Direction and Mean Speed
31.6% W 9.2 Knots
Percent of Time of Second Most Frequent Direction and Mean Speed
15.8% WSW 11.7 Knots
Percent of Time of Third Most Frequent Direction and Mean Speed
15.7% WNW 9.3 Knots
Extreme Peak Gust: 1984 S 67 Knots

Percent of Time Wind Was:
17 Knots or Greater..................................9.6%
11-16 Knots...28.1%
7-10 Knots..37.0%
4-6 Knots...23.7%
1-3 Knots...1.5%
Calm..0.0%

JULY CLIMATOLOGICAL SUMMARY

TEMPERATURES:
Average Daily Maximum............................104
Average Daily Minimum.............................74
Extreme Maximum (1985)..........................119
Extreme Minimum (1981,82,84)...................54

VISIBILITY: *Equal or Greater than*
21/2 Mile...100%
3 Miles..99.8%
6 Miles..99.7%

CEILINGS: *Equal or Greater than*
200 Ft...100%
500 Ft...100%
1000 Ft...100%
3000 Ft..99.5%
5000 Ft..86.1%
No Ceiling...85.6%

PRECIPITATION:
Monthly Mean.......................................0.32”
Extreme Maximum (1998).....................1.39”
ExtremeMin (1980,1993).......................0.00”
24 Hour Maximum (1998).....................1.16”

RELATIVE HUMIDITY:
Mean Relative Humidty.........................27.4%
Mean at 0100L......................................29.3%
0700L......................................35.0%
1300L......................................21.8%
1900L......................................23.3%

FIELD COND. AND SKY COVER:
VFR...100%
IFR...0.0%
Below Minimums...................................0.0%
Mean Sky Cover (eigths)............................2.9
Clear..38.6%
Few (0.1-0.2)..29.8%
Scattered (0.3-0.4).................................13.9%
Broken (0.5-0.7)....................................15.9%
Overcast (0.8)..1.9%

WEATHER CONDITIONS: *(# of days)*
Thunderstorms..1
Rain and/or Drizzle.......................................2
Snow..0
Fog...0
Obstructions to Vision...................................1

PREVAILING WIND DIRECTION AND SPEED

Percent of Time of Most Frequent Direction and Mean Speed
36.8% SW 9.7 Knots
Percent of Time of Second Most Frequent Direction and Mean Speed
10.6% WSW 12.5 Knots
Percent of Time of Third Most Frequent Direction and Mean Speed
10.4% S 10.0 Knots
Extreme Peak Gust: 1982 W 48 Knots

Percent of Time Wind Was:
17 Knots or Greater..................................3.4%
11-16 Knots...24.5%
7-10 Knots...46.6%
4-6 Knots...24.0%
1-3 Knots...1.5%
Calm...0.0%

AUGUST CLIMATOLOGICAL SUMMARY

TEMPERATURES:
Average Daily Maximum............................102
Average Daily Minimum..............................73
Extreme Maximum (1993)..........................120
Extreme Minimum (1990)............................55

VISIBILITY: *Equal or Greater than*
21/2 Mile..100%
3 Miles..99.9%
6 Miles..98.8%

CEILINGS: *Equal or Greater than*
200 Ft...100%
500 Ft...99.6%
1000 Ft...99.5%
3000 Ft...96.9%
5000 Ft...78.7%
No Ceiling...75.2%

PRECIPITATION:
Monthly Mean.......................................0.44”
Extreme Maximum (1998)....................2.39”
ExtremeMin (1978,84,85)......................0.00”
24 Hour Maximum (1982)....................1.80”

RELATIVE HUMIDITY:
Mean Relative Humidty.........................28.4%
Mean at 0100L......................................30.0%
0700L......................................37.0%
1300L......................................22.6%
1900L......................................24.0%

FIELD COND. AND SKY COVER:
VFR..100%
IFR..0.0%
Below Minimums...................................0.0%
Mean Sky Cover (eigths)...........................3.0
Clear...29.3%
Few (0.1-0.2)...43.2%
Scattered (0.3-0.4).................................10.3%
Broken (0.5-0.7)....................................15.0%
Overcast (0.8)..2.2%

WEATHER CONDITIONS: *(# of days)*
Thunderstorms..2
Rain and/or Drizzle.......................................3
Snow...0
Fog...0
Obstructions to Vision...................................1

PREVAILING WIND DIRECTION AND SPEED

Percent of Time of Most Frequent Direction and Mean Speed			
	40.0%	SW	11.8 Knots
Percent of Time of Second Most Frequent Direction and Mean Speed			
	15.1%	W	8.0 Knots
Percent of Time of Third Most Frequent Direction and Mean Speed			
	14.9%	ESE	6.0 Knots
Extreme Peak Gust:	1989,91	W, SW	60 Knots

Percent of Time Wind Was:
17 Knots or Greater.................................3.2%
11-16 Knots...19.8%
7-10 Knots..34.6%
4-6 Knots..36.6%
1-3 Knots...4.7%
Calm...1.1%

SEPTEMBER CLIMATOLOGICAL SUMMARY

TEMPERATURES:

Average Daily Maximum............................97
Average Daily Minimum.............................65
Extreme Maximum
(1990).........................112
Extreme Minimum (1985)...........................48

VISIBILITY: *Equal or Greater than*

21/2 Mile...100%
3 Miles...99.4%
6 Miles...99.3%

CEILINGS: *Equal or Greater than*

200 Ft..100%
500 Ft...99.9%
1000 Ft...99.7%
3000 Ft...97.2%
5000 Ft...87.4%
No Ceiling..84.3%

PRECIPITATION:

Monthly Mean.......................................0.28”
Extreme Maximum (1997).....................2.22”
ExtremeMin (1981,83,84,88,93)...........0.00”
24 Hour Maximum (1997)....................1.44”

RELATIVE HUMIDITY:

Mean Relative Humidty.........................30.4%
Mean at 0100L.....................................30.3%
0700L.....................................35.6%
1300L.....................................27.8%
1900L.....................................28.0%

FIELD COND. AND SKY COVER:

VFR...100%
IFR..0.0%
Below Minimums..................................0.0%
Mean Sky Cover (eigths)...........................2.2
Clear...44.1%
Few (0.1-0.2).......................................29.4%
Scattered (0.3-0.4)................................10.5%
Broken (0.5-0.7)...................................14.2%
Overcast (0.8)...1.8%

WEATHER CONDITIONS: *(# of days)*

Thunderstorms..1
Rain and/or
Drizzle.......................................2
Snow...0
Fog...0
Obstructions to Vision...................................0

PREVAILING WIND DIRECTION AND SPEED

Percent of Time of Most Frequent Direction and Mean Speed

61.1%	W	6.4 Knots

Percent of Time of Second Most Frequent Direction and Mean Speed

16.7%	SW	8.7 Knots

Percent of Time of Third Most Frequent Direction and Mean Speed

11.1%	SE	10.0 Knots

Extreme Peak Gust: 1982,87,90,96 E,S,WSW 42 Knots

Percent of Time Wind Was:

17 Knots or Greater................................2.7%
11-16 Knots..13.0%
7-10 Knots..38.7%
4-6 Knots...36.9%
1-3 Knots..6.6%
Calm...2.1%

OCTOBER CLIMATOLOGICAL SUMMARY

TEMPERATURES:

Average Daily Maximum............................84
Average Daily Minimum.............................54
Extreme Maximum (1987)........................104
Extreme Minimum (1991)..........................32

RELATIVE HUMIDITY:

Mean Relative Humidty.........................23.7%
Mean at 0100L.....................................29.5%
0700L.....................................26.4%
1300L.....................................22.5%
1900L.....................................25.0%

VISIBILITY: *Equal or Greater than*

21/2 Mile...100%
3 Miles...99.8%
6 Miles...99.7%

FIELD COND. AND SKY COVER:

VFR...100%
IFR..0.0%
Below Minimums...................................0.0%
Mean Sky Cover (eigths)...........................1.8
Clear...46.0%
Few (0.1-0.2).......................................22.1%
Scattered (0.3-0.4)................................14.0%
Broken (0.5-0.7)...................................15.3%
Overcast (0.8)...2.6%

CEILINGS: *Equal or Greater than*

200 Ft..100%
500 Ft..100%
1000 Ft..100%
3000 Ft...99.8%
5000 Ft...88.3%
No Ceiling..88.1%

WEATHER CONDITIONS: *(# of days)*

Thunderstorms...0
Rain and/or
Drizzle.......................................2
Snow...0
Fog...0
Obstructions to Vision...................................0

PRECIPITATION:

Monthly Mean.......................................0.14"
Extreme Maximum (1983)....................1.00"
ExtremeMin (1979,80,84,88,95,96).......0.00"
24 Hour Maximum (1983)....................0.71"

PREVAILING WIND DIRECTION AND SPEED

Percent of Time of Most Frequent Direction and Mean Speed			
	50.0%	W	6.8 Knots
Percent of Time of Second Most Frequent Direction and Mean Speed			
	22.2%	SW	6.3 Knots
Percent of Time of Third Most Frequent Direction and Mean Speed			
	5.6%	NW	10.0 Knots
Extreme Peak Gust:	1989	W	48 Knots

Percent of Time Wind Was:

17 Knots or Greater................................4.1%
11-16 Knots..11.6%
7-10 Knots..29.8%
4-6 Knots..40.7%
1-3 Knots..12.0%
Calm...1.9%

NOVEMBER CLIMATOLOGICAL SUMMARY

TEMPERATURES:
Average Daily Maximum............................70
Average Daily Minimum.............................44
Extreme Maximum (1980)..........................92
Extreme Minimum (1984,94).....................27

VISIBILITY: *Equal or Greater than*
21/2 Mile..100%
3 Miles...99.5%
6 Miles...99.0%

CEILINGS: *Equal or Greater than*
200 Ft..100%
500 Ft..100%
1000 Ft..100%
3000 Ft...99.2%
5000 Ft...68.2%
No Ceiling..67.4%

PRECIPITATION:
Monthly Mean.......................................0.14”
Extreme Maximum (1987)....................1.34”
ExtremeMin (1978,80,89,92,93,96).......0.00”
24 Hour Maximum (1987)....................1.27”

RELATIVE HUMIDITY:
Mean Relative Humidty.........................40.7%
Mean at 0100L.....................................49.3%
0700L.....................................51.0%
1300L.....................................27.8%
1900L.....................................34.7%

FIELD COND. AND SKY COVER:
VFR..100%
IFR..0.0%
Below Minimums...................................0.0%
Mean Sky Cover (eigths)...........................3.0
Clear...36.2%
Few (0.1-0.2).......................................25.9%
Scattered (0.3-0.4)................................10.8%
Broken (0.5-0.7)...................................22.4%
Overcast (0.8)..4.6%

WEATHER CONDITIONS: *(# of days)*
Thunderstorms..0
Rain and/or
Drizzle.......................................2
Snow...0
Fog...0
Obstructions to Vision...................................0

PREVAILING WIND DIRECTION AND SPEED

Percent of Time of Most Frequent Direction and Mean Speed
44.4% W 6.9 Knots
Percent of Time of Second Most Frequent Direction and Mean Speed
16.7% NW 9.7 Knots
Percent of Time of Third Most Frequent Direction and Mean Speed
11.1% NW 12.0 Knots
Extreme Peak Gust: 1994 NW 53 Knots

Percent of Time Wind Was:
17 Knots or Greater................................4.8%
11-16 Knots..11.2%
7-10 Knots..30.0%
4-6 Knots...39.2%
1-3 Knots...13.4%
Calm...1.3%

DECEMBER CLIMATOLOGICAL SUMMARY

TEMPERATURES:

Average Daily Maximum............................62
Average Daily Minimum.............................36
Extreme Maximum (1988)..........................81
Extreme Minimum (1990)..........................17

VISIBILITY: *Equal or Greater than*

21/2 Mile..100%
3 Miles...98.5%
6 Miles...98.4%

CEILINGS: *Equal or Greater than*

200 Ft..100%
500 Ft...99.6%
1000 Ft...99.5%
3000 Ft...99.0%
5000 Ft...67.2%
No Ceiling..65.8%

PRECIPITATION:

Monthly Mean.......................................0.50”
Extreme Maximum (1984).....................1.66”
ExtremeMin (1981,86,90,95,96)...........0.00”
24 Hour Maximum (1987)....................0.71”

RELATIVE HUMIDITY:

Mean Relative Humidty.........................46.9%
Mean at 0100L.....................................51.5%
0700L.....................................57.5%
1300L.....................................35.0%
1900L.....................................43.5%

FIELD COND. AND SKY COVER:

VFR..100%
IFR..0.0%
Below Minimums...................................0.0%
Mean Sky Cover (eigths)...........................3.7
Clear...27.7%
Few (0.1-0.2).......................................14.2%
Scattered (0.3-0.4)................................24.7%
Broken (0.5-0.7)...................................26.3%
Overcast (0.8)...7.1%

WEATHER CONDITIONS: *(# of days)*

Thunderstorms..0
Rain and/or
Drizzle.......................................3
Snow...1
Fog...1
Obstructions to Vision...................................0

PREVAILING WIND DIRECTION AND SPEED

Percent of Time of Most Frequent Direction and Mean Speed			
	37.5%	W	7.7 Knots
Percent of Time of Second Most Frequent Direction and Mean Speed			
	18.8%	WNW	8.0 Knots
Percent of Time of Third Most Frequent Direction and Mean Speed			
	12.5%	NW	9.0 Knots
Extreme Peak Gust:	1983	SW	50 Knots

Percent of Time Wind Was:

17 Knots or Greater................................5.6%
11-16 Knots..13.0%
7-10 Knots..36.0%
4-6 Knots..29.5%
1-3 Knots..10.6%
Calm...5.6%

SECTION III

FORECASTING

1. **Local Forecasting Procedures and Techniques**:

a. **Introduction**: The Expeditionary Airfield operates under a high operational tempo during CAX periods. The garrison weather office provides weather support available to both air and ground units deployed here during both training and non-training periods. Both permanent and augmented personnel need to keep in mind both subjective and objective rules concerning forecasting in this unique training environment.

2. **Subjective Forecasting Rules**

a. **Summer Regime**

(1) Cloud bases tend to be higher than 3,500 feet because of barrier and lifting effects of the San Bernardino Mountains.

(2) The Thermal Low is a significant feature here in the high desert region. Careful attention to wind direction with respect to wind speed is very important. A light southeasterly flow between 5-10 knots during the early morning hours is a good indication that winds in afternoon may increase due to the thermal lows beginning to fill once peak heating is reached. Wind blowing out of Banning Pass generally has a direction of 210 to 220 degrees. Wind speed may exceed 40 knots locally and 50 knots through the passes. Continuity on a daily basis plays an important role in forecasting.

(3) Maximum temperatures here each day are fairly constant but extreme heating does occur, normally: when the thermal low in Arizona extends northward into Nevada or when the Pacific High ridges inland into the deserts temperatures have been known to exceed 120 degrees.

(4) Maximum heating occurs between 1500 and 1800 local each day. Daily temperatures decrease to less than 100 degrees between 1800 and 2100 local each evening.

(5) Blowing sand begins to lift with sustained wind of 30 knots and higher. Also, gusts of 30-40 knots will lift dust in the local area. Sustained wind of 30 knots and higher for extended periods of time will lift sand and dust well into the air (i.e. 50 feet and higher) and cause visibility problems. If a recent wind storm has occurred, dust may lift even after 20 knots of wind.

(6) The period that covers mid-July through September brings occasional significant rises in humidity. The **"monsoonal flow"** that occurs during this period increases the probability of thunderstorm development. Parameters to look for are as follows:

a. Development of cumulus prior to **0900L** surrounding the local forecasting area, i.e. over the mountains and Joshua Tree National Park.

b. Thunderstorm activity from the previous day (continuity with pronounced moonsoonal flow).

c. Unstable atmosphere indicated on the Twentynine Palms Skew-T during periods of moderate southerly flow, +02 or less using the Showalter Index.

d. Pilot Reports. Particular close attention to the tops of cumiliform cloud layers. Particularly over the mountain ranges.

(7) A good "rule of thumb" when you are forecasting for afternoon thermal winds is pressure differences between Twentynine Palms and LAX (Los Angeles). Generally, when you begin to get southeasterly winds (4-8 knots), keep an eye on the pressure differences between NXP and LAX. With a pressure difference of 8 millibars or greater, southwesterly winds generally begin 1-3 hours with sustained winds 14-18 knots with gusts 25-30 knots and higher.

b. **Winter Regime**

(1) Winter Storms from the North Pacific and the Canadian Northwest produce the most intense weather in the Mojave Desert. An extensive discussion is found in Chapter II of Winter Systems and Shearing Cold Fronts that effect the Twentynine Palms area.

(2) Cold fronts crossing the coastal mountains and the Sierra Nevada Range undergo such drying in the lower layers that normal identification by satellite interpretation isn't possible. Surface winds are your strongest indication of frontal passage.

(3) Frontal activity and/or shortwave troughs moving through this area are prime hazards to flying and ground operations. Adequate lead time can be provided by recognizing prime synoptic suspect areas:

(a) A front embedded in strong shortwave trough.

(b) A well developed jet stream over Southern California.

(c) The development of a Nevada Low or Tonopah Low.

(4) Surface winds prior to a trough/cold frontal passage will be southeast or southwesterly depending upon orientation of the system. These winds can proceed the trough/front by 24 hours and typically move at an average of between 15-25 knots.

(5) Approaching fronts typically are proceeded by low level stratocumulus (Layers in the desert generally form between 3000 and 5000 feet).

(6) Severe low pressure centers (Nevada lows) in conjunction with a high pressure ridge to the west sets up a strong wind field from the northwest and north. The wind field sets up very rapidly with little to no warning. Very close observation for the development of Nevada lows during the winter months is paramount. (Note: Nevada lows and their development are discussed extensively in Chapter III).

(7) Jet maximums that move along the jet stream act as a trigger mechanism for Nevada lows. It is important for the forecaster to look at the orientation of the Jet stream. Typically, especially during transitional periods, Nevada Lows tend to form in cold air over the southern tip of Nevada.

(8) Santa Ana winds normally do not present a major problem for the EAF. It is generally a coastal phenomenon that lasts 24 to 48 hours with longer periods during the November, December and January time frame.

c. **Objective Forecasting Rules**: Many objective forecasting rules would include a continuous state of preparedness in regards to forecasting. The additions of the MIDDS and ASOS have opened new avenues in the collection and dissemination of weather data.

3. **Forecast Format (Daily)**:

a. **DD-175-1's and HWD's.** DD-175's are prepared on all IFR/VFR flights originating from the MCAGCC. HWD's are prepared whenever requested for flights over 200 NM.

b. **Daily Forecast.** This forecast is prepared by 0700L, in accordance with the local directives.

(1) Daily Forecast

(2) Astronomical data (48 hour period)

(3) A daily synopsis of the Western U.S.

(4) Significant weather covering the local flying area to include turbulence, upper level winds, thunderstorm development, etc.

(5) Daily forecast includes a 72 hour outlook

(6) Strike briefs are provided during Combined Arms Exercises upon request.

c. **Joshua Tree Plain Language Forecast**. Forecast is prepared by 0730L and faxed to the National Park Service.

d. **TAF.** TAFS are prepared in accordance with criteria established COMNAVMETOCOM and local instructions. It is the forecaster's responsibility to ensure that the observational watch monitors changing weather conditions and that amendments are issued expediently. All forecasts have a valid time of 24 hours and are issued at the following times: 03Z, 09Z, 15Z, and 21Z respectively.

e. **<u>WEAX:</u>** Issued during CAX periods or by request.

4. **<u>Advisories, Weather Warnings, and Conditions of Readiness</u>**:

a. **<u>Weather Advisory</u>**: Issued to give projected notification that hazardous or destructive weather is in the developing stage or could develop.

b. **<u>Weather Warning</u>**: Issued to notify that destructive weather or hazardous weather is expected to occur in the local area.

c. **<u>Tornado/Thunderstorm Condition II</u>**: Thunderstorms or tornadoes are expected to occur within 50 nautical miles of the airfield.

d. **<u>Tornado/Thunderstorm Condition I</u>**: Thunderstorms or tornadoes are imminent and expected to pass within 5 nautical miles of the airfield.

e. **<u>Tower Wind Advisory</u>**: Will be issued to the tower when surface winds of 15-19 knots are occuring. *This will be a **tower advisory** only*

f. **<u>Local Wind Warning</u>**: Winds sustained 15 to 33 knots are occurring within the Local Area.

g. **<u>Gale Warning</u>**: Winds sustained 34 to 47 knots are occurring within the Local Area.

h. **<u>Storm Warning</u>**: Winds sustained 48 to 63 knots are occurring within the Local Area

i. **<u>Hurricane Force Winds</u>**: Winds sustained 64 knots or greater are occurring within the Local Area.

j. **<u>Earth Quake Reports:</u>** Reports are filled out and given to the weather Service Officer for review prior to submission.

k. **<u>Freeze Advisory</u>**: Freeze advisories will be sent out any time the temperature is forecasted to fall below 0 degrees Celcius.

l. **<u>Flood Warning</u>** : Flood warnings will be set any time the local area is forecasted to have ½ in. of rain or more per hour.

m. **<u>Readiness Conditions</u>**: Readiness Conditions establisha state of preparedness designed to minimize personal injury and damage to property and equipment. Readiness conditions are issued by the Commanding Officer, MCAGCC, and include the following:

Condition V. Secure from condition. Threat of storm has passed. Return to normal operations.

Condition IV. Destructive winds are possible within 72 hours.

Condition III. Destructive winds are possible within 48 hours.

Condition II. Destructive are anticipated within 24 hours.

Condition I. Destructive winds imminent or anticipated within 12 hours.

Condition IE (Emergency). Destructive winds are being experienced.

SECTION IV

SPECIALIZED FORECASTS

1. **Discussion**: Any number of specialized forecast may be requested from this facility. The most frequent are listed below:

2. **Radiological Fallout (RADFO)**: This forecast, (not routinely prepared) is available upon request. It is essential that the forecaster and observer are familiar with the procedure and references. The pattern of deposit concerning contaminated particles (fallout) varies greatly with the upper air circulation, vertical motion, clouds, and or precipitation Predictions of fallout areas depend upon many assumptions about such things as weapons yield, burst type, nature of surface, and meteorological factors. These predictions are not precise. However, it is important that planners and commanders have at least an approximate warning of the areas of serious contamination. This information will be obtained by utilizing the MOSS and GFMPL Programs.

3. **Blast Focusing**: Blast Focusing is the abnormal concentration of sound waves due to bending (refraction) and focusing in a particular direction or sector along the surface of the earth, instead of the uniform distribution in all directions. There are no requirements at the Combat Center due to its location in proximity to populated areas.

4. **OPARS**: Pilots flying aircraft involved with extended flying missions may request OPARS support through this facility. Although not routinely prepared, such request are available.

5. **EOTDA's**: Night Vision Goggles are used on a frequent basis at MCAGCC. It is essential that the forecaster be familiar with the procedures and references for receiving a request and processing an EOTDA. The hardware/software and user's manual are located in safe at the CMCC. EOTDA Ops worksheets for TV, IR and Laser requests are located in the forecaster's ready reference and in the CMCC.

6. **RADAR PROPAGATION (REFRACTIVE INDEX):** This forecast (FXUS Series) describes the effects that the environment will have on refraction of radar waves in the atmosphere and may be used to correct and account for abnormal refraction of possible combat controlling radar.

7. **CHEMICAL DEFENSE:** Hazards from chemical attacks are not confined to areas directly attacked. The vapor or aerosol will travel with the wind and may produce casualties among unprotected personnel downwind. Speedy identification of likely hazard areas and dissemination of area computation are necessary to prevent further casualties. The VLSTRACK program contains simple techniques for use by environmental forecasters in estimating the downwind hazard areas resulting from chemical attacks.

8. **Chemical Downwind Messages (CDM's)** : This forecast is included in the WEAX. It is essential that the forecaster be familiar with the procedures and references. CDM's are only valid

for six (6) hours and require a coded message that can be found in the forecaster reference, or be obtained from NBC personnel.

SECTION V

ENVIRONMENTAL EFFECTS

1. **Introduction:** Significant effects concerning natural phenomena may affect aircraft, facilities, operations and aircraft weapons systems. Also, construction as well as personnel may be effected. It is imperative that commanders are alerted in a timely manner. The primary purpose of this section is to provide information and explanations relative to environmental effects.

2. **Pollutants**: The Los Angeles Basin is known for its photochemical pollutants (aerosols). The frequency and intensity of smog episodes are some of the most severe of any urban America. The Airfield is not subject to a smog or population problem. The Smog that leaves the Los Angeles area depending on wind flow generally moves through Banning Pass and the Palm Springs Region. The San Bernardino Mountains act as a sufficient barrier to prevent pollution.

3. **Runway Temperatures**: The hot summer temperatures routinely effect the lifting capabilities of rotory wing aircraft. Fixed wing aircraft also experience lift and payload problems. Pressure altitudes vary between +1800 and +2150 feet. Density altitudes during the summer months can peak as high as +6500 feet on a hot day. These figures are reflected at elevations just above the 10,000 foot mark as the thermal low develops each day throughout the summer months.

4. **Crosswinds**: Crosswinds can be a serious problem at the Expeditionary Airfield. The only active runway here (28-10) presents a problem when winds blow out of a southwesterly component i.e. (approaching cold front, thermal winds from Banning Pass.) The M-21 Arresting gear is an added safety feature for all tailhook equipped aircraft. Any aircraft that utilizes the arresting gear can be stopped in only a plane length, eliminating the hazards of a long roll in crosswind conditions.

Aircraft	Crosswinds	Cannot Takeoff
F/A-18 Hornet	20 Knots at 090	30 Knots at 090
KC-130 Hercules	10 Knots at 090	15-20 Knots at 090
UC-12B Beachcraft	15 Knots at 090	25 Knots at 090
CT-39G Saberliner	20 Knots at 090	30 Knots at 090 (dry) 25 Knots at 090 (wet)
AV-8A/B Harrier	20 Knots (Conventional)	30 Knots Wet (Vertical take-off)

UH-1 Huey	45 Knots relative wind/ 60Knots in emergency
AH-1 Cobra	45 Knots relative wind/ 60Knots in emergency
CH-46 Sea Knight	45 Knots relative wind/ 60Knots in emergency
CH-53 Sea Stallion	45 Knots relative wind/ 60Knots in emergency

5. **Flight Hazards**: Provides a graphic display that shows individual aircraft sensitivities to icing, turbulence and weather.

6. **Turbulance/ Icing factors for Aircraft**

(1) H-1/ AH-1J+W/ CH-53+46 & C-12 are not allowed to file into areas of known extreme turbulance.

(2) Icing capabilities of different aircraft

Type	De-ice	Anti-ice	Max icing	Wx Radar
F/A-18	X	X	Moderate	Yes
AV-8B2+		X	Moderate	80 NM
KC-130	X		Severe	240 NM
UC-12B	X	X	Light	200 NM
CT-39G	X		Light	300 NM

7. **Thunderstorm Refueling**: All refueling will stop when the airfield is in Thunderstorm I. Communication Channels between Operations Duty Officer and Duty Forecaster are kept open as much as possible during thunderstorm activity to monitor fuel/flight hazards.

8. **Heat Stress (Wet Bulb Temperature Index) WBGT:** Heat Stress is a major problem during summer operations. Many Marines travel to the desert from coastal stations. The two greatest dangers are the level of physical activity and the amount of fluid intake. It is extremely important that units here for 1 to 2 months are briefed on daily heat stress conditions. The Expeditionary Airfield provides hourly WBGT readings with updates as they apply. The Combat Center on mainside, also provides WBGT readings daily. It should be noted that WBGT conditions apply to personnel that are acclimated to desert temperatures. All augmented personnel operating in the field should take extreme caution about heat stress, prime heating hours, and especially water intake. Enter the graph on the left hand side with the forecasted maximum temperature and on the right hand side with the forecasted humidity. Where they intersect use the value of "A, B, C, D, or E" and refer to the ledger in the bottom left hand corner for the humidity factor.

9. **Wind Chill Factors:** Wind Chill factors can dip below zero in the deserts with the combination of cool temperatures and high winds during the winter months. Some portion of the Combat Center operations occur at higher elevations which can dip even lower.

SECTION VI

REFERENCES

1. <u>Local Area Forecaster's Handbooks:</u>

MCAS YUMA
MCAS CAMP PENDLETON
MCAS EL TORO

2. <u>Climatology</u>: Local Monthly Climatological Records 1961-Present.

3. <u>Other References</u>

Orographic Influences on Flow and Precipitation Patterns in the Desert.
Author: Sterling Anderson.

Robert T. Banks (Earthquakes in Southern California) 1993

Jet Streams of the Atmosphere (NAVWEPS 50 -IP-549)

Theory of Continental Drift: Author T.W. Martin 1990.

Operations Manual for Expeditionary Airfield Twentynine Palms, California 1994.